FINAL
PRELIMINARY ASSESSMENT REPORT
SNAKE PIT SITE
FORMER US BIGGS ARMY AIR FIELD
FORT BLISS, EL PASO, TEXAS

Prepared for:

U.S Army Corps of Engineers
Tulsa District

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LIST OF ACRONYMS

%	percent
AOC	area of concern
AOI	area of interest
APP	Accident Prevention Plan
BAAF	Biggs Army Air Field
bgs	below ground surface
CPM	counts per minute
Cs	cesium
DGM	Digital Geophysical Mapping
EM	Electromagnetic
ft	foot or feet
GIP	Geophysical Investigation Plan
GPR	Ground Penetrating Radar
GPS	Global Positioning System
GSSI	Geophysical Survey Systems, Inc.
HEU	highly enriched uranium
IL	investigation level
mS/m	millisiemens per meter
NaI	sodium iodide
NTP	Notice to Proceed
PA	Preliminary Assessment
ppt	parts per thousand
PVC	polyvinyl chloride
QC	Quality Control
SOW	Scope of Work
SSHP	Site Safety and Health Plan
UFP-QAPP	Uniform Federal Policy – Quality Assurance Project Plan
USACE	U.S. Army Corps of Engineers

LIST OF ACRONYMS (CONTINUED)

USAEC	U.S. Army Environmental Command
UTM	Universal Transverse Mercator
WESTON®	Weston Solutions, Inc.
WGS 84	World Geodetic System 1984

1. INTRODUCTION

1.1 PROJECT AUTHORIZATION

U.S. Army Corps of Engineers (USACE) Tulsa District contracted Weston Solutions, Inc. (WESTON®) under Contract No. W912BV-10-D-1004, Task Order 12, to perform a Preliminary Assessment (PA) of the Snake Pit Site at the Former US Biggs Army Air Field (BAAF) at Fort Bliss, Texas. The task order was authorized with a Notice to Proceed (NTP) on 17 September 2014.

1.2 PURPOSE AND SCOPE

Fort Bliss requested the PA of four areas of interest (AOIs) at the former BAAF Snake Pit Site to identify potential burial locations of low-level radioactive wastes in close proximity to maintenance facilities. Based on historical operations, there is potential that former generation of weapons-related waste could have been buried onsite from 1955 to 1959. The assessment was performed in accordance with the Scope of Work (SOW), dated 5 August 2014, summarized below.

- **Tasks 1 and 2 – Planning and Pre-mobilization**: The WESTON team prepared a site-specific Uniform Federal Policy – Quality Assurance Project Plan (UFP-QAPP) (WESTON, 2015a) to provide details of the technical approach, methods, and operational procedures that would be employed in conducting this PA. WESTON also prepared an Accident Prevention Plan (APP) / Site Safety and Health Plan (SSHP), which was submitted as an attachment to the UFP-QAPP prior to the commencement of work.

- **Task 3 – Surface Gamma Radiation Survey**: A surface gamma radiation survey of the 32 acres associated with the four AOIs was conducted to determine whether potential sources of low level radiation were present.

- **Task 4 – Geophysical Investigation**: Digital geophysical mapping (DGM) surveys were performed over AOIs totaling 32 acres. The objective of the DGM survey was to identify potential pit and trench-like features that may contain buried waste. Locations exhibiting features of interest were further assessed using ground penetrating radar (GPR) to determine if additional intrusive investigations were required.

- **Task 5 – Subsurface Gamma Radiation Survey:** A subsurface gamma radiation survey was conducted on areas selected for further investigation based on results from the surface gamma radiation survey and geophysical investigation.

- **Task 6 – Report**: This report documents the results of the PA, including the gamma radiation survey and geophysical investigation.

1.3 PRELIMINARY ASSESSMENT REPORT ORGANIZATION

This PA Report discusses Quality Control (QC) requirements, data collection procedures, and results. The Report is organized into the following sections:

- Section 1 – Introduction
- Section 2 – Site Description, Operational History, and Waste Characteristics
- Section 3 – Potential Pathways and Environmental Hazard Assessment
- Section 4 – Gamma Survey and Geophysical Investigation
- Section 5 – Summary and Conclusions
- Section 6 – References

2. SITE DESCRIPTION, OPERATIONAL HISTORY, AND WASTE CHARACTERISTICS

2.1 SITE LOCATION AND DESCRIPTION

Fort Bliss is the U.S. Army's primary training center for ground-to-air missile batteries and encompasses areas of west Texas, including El Paso and south-central New Mexico. The reservation occupies approximately 1.2 million acres across the two states and three counties (Dona Ana, New Mexico; Otero, New Mexico; and El Paso, Texas). The Snake Pit Site is approximately 189 acres located northwest of BAAF. Site location is shown on **Figure 2-1**.

2.2 SITE HISTORY AND CHARACTERISTICS

The BAAF was formerly a nuclear-capable installation from 1954 to 1966. During this period, BAAF was an operational storage site with a weapons storage area. Maintenance on the early open-system type weapons generated waste such as rags that could have been contaminated with small amounts of radioactive materials. Such waste could be low level radioactive waste (LLRW).At that time, it was common practice to place the low-level radioactive waste in cardboard boxes, wooden boxes, or metal containers and bury it within close proximity of the maintenance buildings. These containers were likely disposed in trench or pit type features, or in cylindrical wells, below ground surface (bgs).

Based on information provided in the July 2014 Memorandum for Record, a former nuclear weapons maintenance technician indicated that low level radioactive waste was placed in standard cylindrical steel cans that were sealed with a locking ring. The cans were labeled as radioactive before being disposed of in boreholes that were dug approximately 12 feet (ft) deep and 18–24 inches in diameter (Fort Bliss, 2014).

The potential waste materials subject to burial from 1955 to 1959 may include metal buckets, cloth rags, and other metallic and non-metallic material. Uranium and tritium from maintenance activities would likely have been at low levels on rags/tissues. Some small weapons components that would have been replaced during maintenance events could have been buried as waste, but would have been inert or have contained cesium (Cs)-137. In 2013, the Air Force conducted

wipe sampling of the buildings (Storage Bunkers) at the site to test for radiological compounds, and results were negative. Waste may have been removed from the Site as was common practice at other similar sites; however, removal has not been verified at the Snake Pit Site.

The Snake Pit Site currently consists of multiple structures and undeveloped land. Potential burial sites at the Snake Pit Site were identified based primarily on historical accounts from personnel familiar with the former operations, as outlined in the July 2014 Memorandum for Record. Descriptions of the AOIs and associated features investigated as part of this PA are listed below and shown on **Figure 2-2**:

- **AOI 1** - Storage Igloos, C-Structures, and Former Building 11508 Concrete Slab: Three storage igloos (Buildings 11506, 11512, and 11514), two C-structures (Buildings 11507 and 11513), and the residual slab of Building 11508 are located on approximately 10 acres on the northern end the Snake Pit Site. These structures are configured in a grid arrangement. Previously, these buildings were used for the storage of unsealed nuclear weapons. Buildings 11506, 11507, 11512, 11513, 11514, and former Building 11508 are located within the proposed boundaries of AOI 1.

- **AOI 2** - Maintenance & Inspection (M&I) Building, Guard House, and All Other Structures: Located along the eastern flank of the site, the M&I Building was used for maintenance of unsealed nuclear weapons systems and is thought to be the area where much of the low-level radioactive waste was generated. Waste is suspected to have been buried in close proximity to the M&I Building. The M&I Building and surrounding area west of the road compose the approximate 8-acre AOI 2. Two temporary storage structures, a guard house, and other buildings are located the east and south of the M&I Building and outside the boundaries of AOI 2.

- **AOI 3** - Undeveloped land: The western and southern flanks and center of the site are vacant, with historical structure footprints of temporary buildings from 1956 and a World War II High Tower Turret Skeet Range. Several old dirt roads traverse the vacant land. AOI 3 consists of approximately 10 acres and is located across the northern portion of the vacant land.

- **AOI 4** - Overburden area: A constructed arroyo was created in the southeastern corner of the Snake Pit Site in the area of AOI 4. The removed soil was spread on either side of the feature. AOI 4 is approximately 4 acres and is located on the northeastern flank of the arroyo and west of the guard house. The fill placed on AOI 4 was observed during the project kick-off meeting to be approximately 8 ft above grade. The fill is generally located in the line of sight of the guard house (shown on **Figure 2-2**), an area identified as associated with potential waste burial activities based on previously conducted interviews with former Fort Bliss personnel.

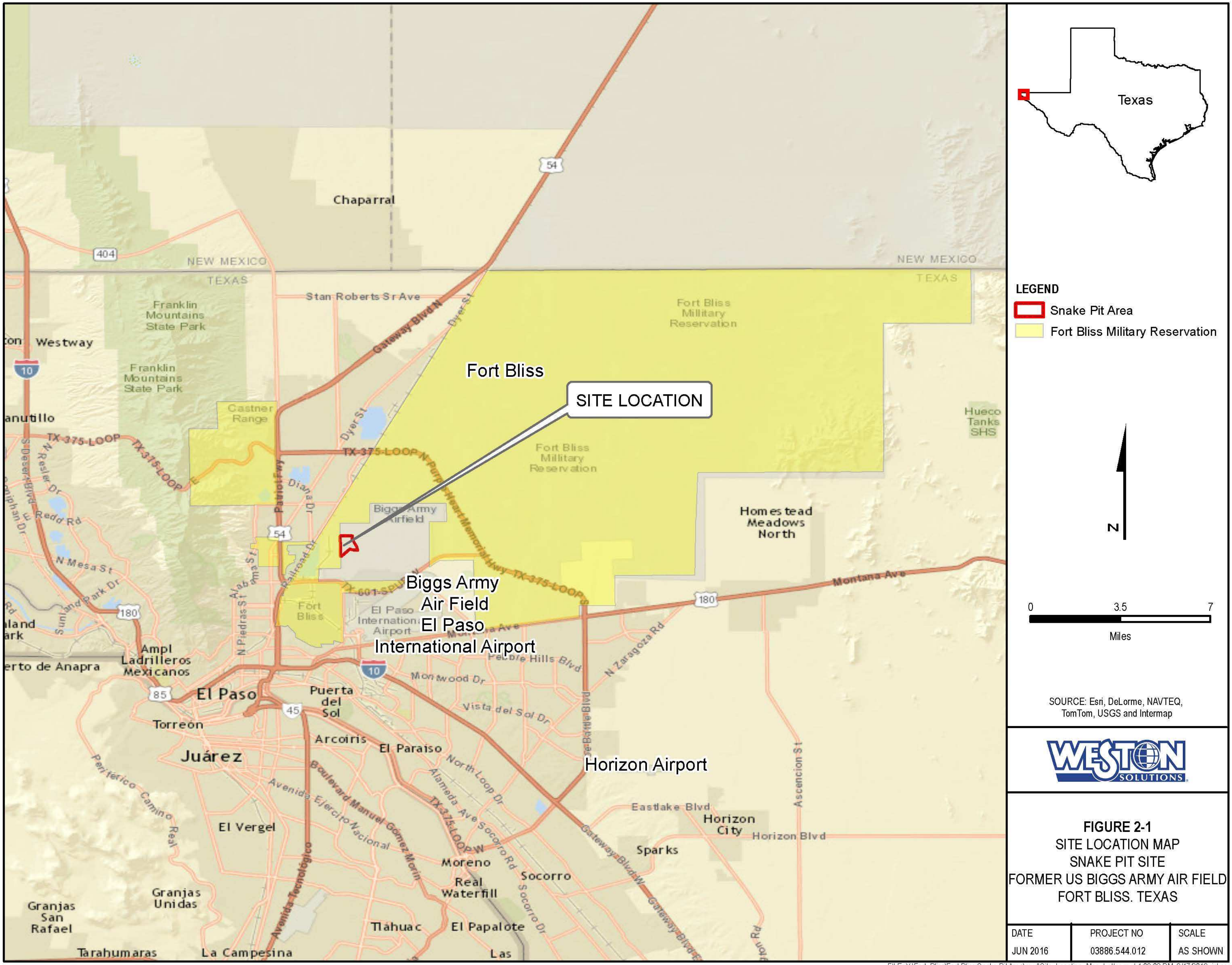

FIGURE 2-1
SITE LOCATION MAP
SNAKE PIT SITE
FORMER US BIGGS ARMY AIR FIELD
FORT BLISS. TEXAS

DATE	PROJECT NO	SCALE
JUN 2016	03886.544.012	AS SHOWN

FILE: Y:\Fort_Bliss\Fort Bliss Snake Pit Area\mxd\Site_Location_Map_Letter.mxd 1:06:08 PM 6/17/2016 ricksc

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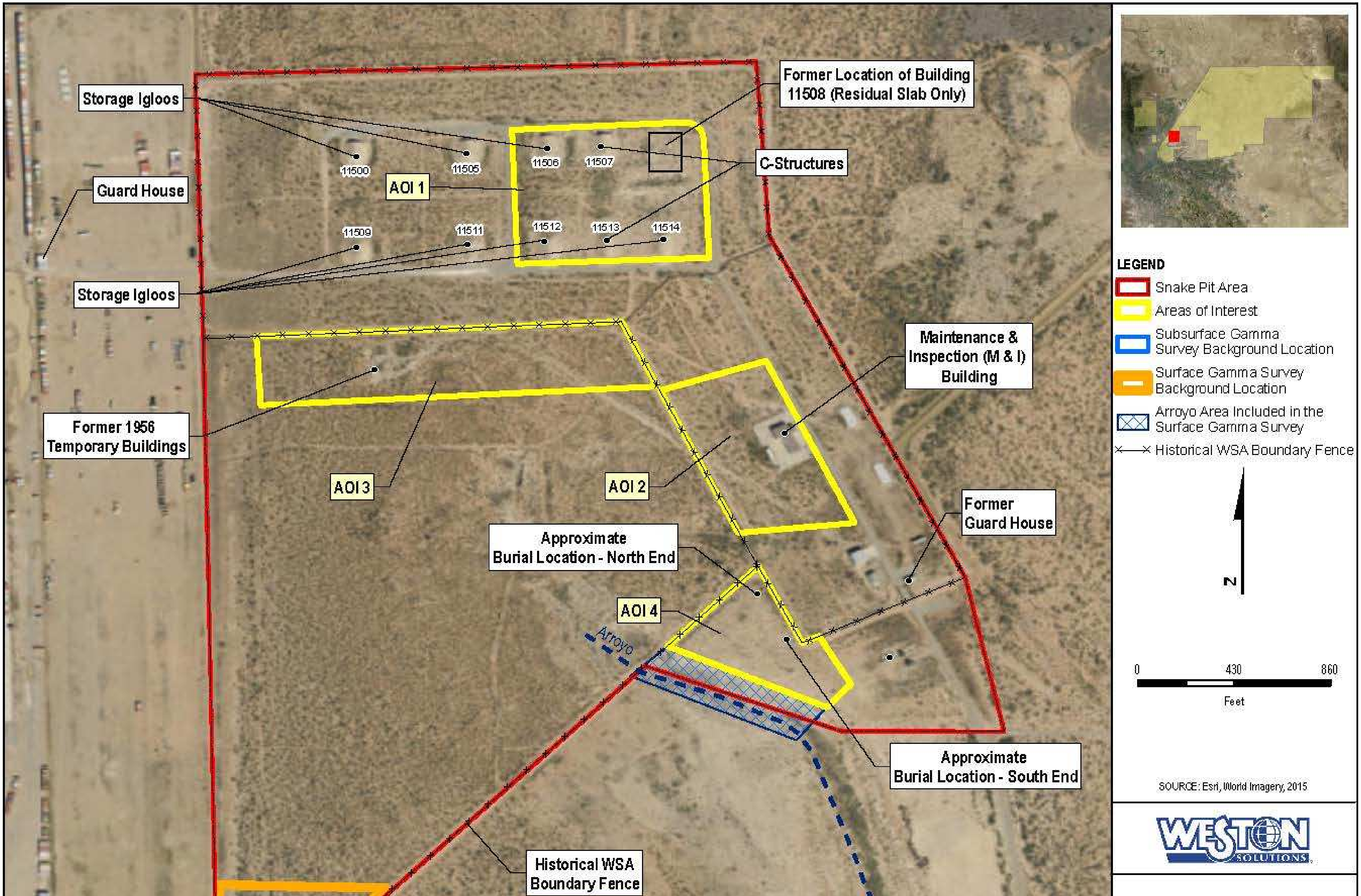

FIGURE 2-2
AREA OF INTEREST LOCATION MAP
SNAKE PIT SITE
FORMER US BIGGS ARMY AIR FIELD
FORT BLISS, TEXAS

DATE	PROJECT NO.	SCALE
DEC 2016	03886.544.012	AS SHOWN

FILE: I:\GIS Project Files\03886_Corps of Engineers\Fort Bliss Snake Pit Area\mxd\Figure 2-2 AOI Location Map.mxd 4:12:52 PM 12/2/2016 herrinm

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3. POTENTIAL PATHWAYS AND ENVIRONMENTAL HAZARD ASSESSMENT

3.1 GROUNDWATER

3.1.1 Hydrogeologic Setting

Fort Bliss is located within the Hueco Bolson basin, which is associated with an alluvial aquifer system. The primary groundwater supply for the Fort Bliss area is derived from wells located in the relatively shallow Hueco Bolson Aquifer (USACE, 1991). One hundred (100) to 350 ft of Rio Grande alluvium overly the aquifer sediments that primarily consist of unconsolidated Tertiary-Quaternary age gravels, silts, sands, and clays. Basin sediments are derived from the Franklin Mountains to the west and the Hueco Mountains to the east. The basin is bound by several major faults, the nearest being about four miles west of the site on the flank of the Franklin Mountains. The faults have not been reported as active (WESTON, 1999).

3.1.2 Groundwater Pathway

The depth to groundwater at Fort Bliss is over 300 ft bgs. Therefore, a potential release from low level radioactive waste, if present, is not expected to present a risk to groundwater, and the pathway is not considered to be complete.

3.2 SURFACE WATER

3.2.1 Hydrologic Setting

Surface water features at Fort Bliss are limited and include ephemeral streams and playas. The surface water features are not considered waters of the state and are not subject to the Clean Water Act (Fort Bliss, 2013). The topography of the Snake Pit site is relatively flat. Stormwater runoff flows generally to the south, toward a constructed arroyo adjacent south of AOI 4. The arroyo is an ephemeral feature that conveys stormwater from the Snake Pit Site in the general southeast direction.

3.2.2 Surface Water Pathway

The nearest surface water feature to the AOIs investigated as part of this PA is the constructed arroyo adjacent south of AOI 4. No perennial surface water features are located downstream of the Snake Pit Site. No populations in the vicinity of the Snake Pit Site are served by surface water. Due to the location of the arroyo adjacent downstream of AOI 4, the surface water pathway is considered potentially complete.

However, radioactive material above normal background was not detected in the surface soil of AOI 4 and therefore, would not contribute to the surface water pathway due to runoff. Additionally, a surface gamma scan was conducted as part of the PA field activities along the portion of the arroyo that extends along the boundary of AOI 4 (**Figure 2-2**). As discussed in Section 4.2.4, the surface gamma scan did not show any areas of elevated activity. Elevated readings appeared to be associated with the surface expression of the differing underlying sediment types exposed from the widening of the drainage pathway, which have slightly higher gamma readings than the natural surface cover in the area.

3.3 SOIL EXPOSURE AND AIR

3.3.1 Physical Conditions

Soil present at the Snake Pit Site consists primarily of Cavalry loamy fine sand, with one to three percent (%) slopes. Cavalry loamy fine sand is characterized as well drained soil with very low runoff (NRCS, 2016). The permeability of the soil is moderate.

As discussed in Section 2.2, approximately 8 ft of fill is present at AOI 4. Therefore, surface surveys are believed to only characterize fill material. Native soils observed during drilling operations included the following: 2 ft of a clayey, silty sand, brown, dry, unconsolidated layer at the surface; that overlays an approximately 6-ft layer of caliche, with intermittent layers of sands of various thicknesses; that overlays a gravely sand, light gray, dry, unconsolidated with intermittent layers of fine sand, to the base of all borings. Soil borings are included in **Appendix A**.

3.3.2 Soil and Air Pathways

There are no permanent residences, schools, or day care facilities onsite or within 200 ft of the Snake Pit Site. The nearest occupied structure (a guard shack) is located approximately 600 feet west of the Snake Pit Site. The Snake Pit Site is fenced and secure from entry by the general population. The site is located within an inactive area of Fort Bliss; therefore, based on the count rates encountered at the site, no significant risk above normal background radiation exposure to personnel is expected. However, based on the site history as discussed in Section 2.2, the soil pathway is considered potentially complete.

4. GAMMA SURVEY AND GEOPHYSICAL INVESTIGATION

The gamma survey and geophysical assessment were performed during two events. The first event was conducted in May through June 2015 and included non-intrusive surface gamma survey, EM survey, and GPR survey methods, in conjunction with Global Positioning System (GPS) navigation techniques performed over the four AOIs. The results of the assessment were evaluated to select areas for further evaluation with subsurface gamma survey methods, which were conducted during the second field event 25–29 April 2016. A surface gamma scan of the arroyo adjacent south of AOI 4 was also conducted during the second field event. Surveys were completed in accordance with the April 2015 *Uniform Federal Policy – Quality Assurance Project Plan (UFP-QAPP) for Preliminary Assessment at US Biggs Army Air Field – Snake Pit Site, Fort Bliss Texas* (WESTON, 2015a) and the December 2015 Amended UFP-QAPP (WESTON, 2015b). Details of the survey descriptions and results are presented in the following subsections.

4.1 SURFACE SURVEY DESCRIPTIONS

4.1.1 Location Surveying

WESTON used a Trimble GEOXH 6000 GPS instrument, which was interfaced with the EM, GPR, and gamma survey equipment, to establish control and provide reference for data collection to sub-meter accuracy. Coordinates for the boundaries of the AOIs, anomaly locations identified during the surveys, and features/debris that might have interfered with the surveys were geo-referenced via the GPS and incorporated into site maps, where possible. The locations, orientations, and layouts of traverses were recorded using the World Geodetic System 1984 (WGS 84) coordinate system, Universal Transverse Mercator (UTM) Zone 13N coordinate system in units of meters.

4.1.2 Electromagnetic (EM) Terrain Conductivity Surveying

Full coverage EM surveys at 5ft line spacing across 32 acres were complete at the site. The EM survey was conducted using a Geonics, Ltd. EM31-MK2 terrain conductivity meter, coupled with a GPS unit. The instrument measures apparent conductivity in units of millisiemens per

meter (mS/m) in materials with true conductivity ranging up to 1,000 mS/m. The EM31-MK2 survey was conducted using both the *quadrature* and *in-phase* components. The *quadrature* component is sensitive to conductors with low induction numbers (i.e., low conductivity materials/soils). The *in-phase* component is sensitive to conductors with a higher induction number (i.e., more conductive materials such as buried metal objects).

Prior to use each day, the instrumentation was calibrated in accordance with manufacturer specifications. After calibration, and performing instrument function checks, both the quadrature and inphase components were measured at the site. The instrument was operated using the vertical dipole mode of operation, which changes the geometry of the transmitted/received signal to yield information from greater depths. The effective depth of exploration associated with this mode of operation is approximately 18 ft (McNeil, 1980).

The EM31-MK2 was interfaced with the GPS to provide real time locations. Transect lines were generally collected along the long axis of the survey area and spaced at approximate 5-ft intervals. Data were collected with the instrument set at 10 hertz (10 readings per second) for a “continuous mode” of data collection, with a measurement obtained approximately every 1 to 2 ft along each transect to provide high density data. As the operator advanced along each transect, measurements were digitally recorded and stored in memory using an Allegro CX Data Logger®.

Boundaries of the AOIs were loaded onto the GPS, navigated to, and marked with pin flags. The majority of the AOIs were bound by identifiable features such as fence lines and roads and did not require much staking out. Control points for transects were established using road cones and non-metallic pin flags to help the operator navigate along parallel lines within the survey areas. This approach proved very precise and efficient and ensured comprehensive coverage of the survey area. It facilitated collection of high density and symmetrical data, which greatly enhanced the resolution of buried features and anomalies.

The EM31-MK2 survey data were stored in an Allegro CX Data Logger® and later downloaded to a field laptop computer. Features such as foundations, pipelines, fence lines, power lines, and surface debris were located and stored within the GPS unit. The computer-generated output files were formatted and processed to prepare conductivity and inphase plots, utilizing the OASIS

Montaj mapping software by Geosoft™. Data collected as part of the PA are included in **Appendix D**.

DGM Survey Quality Control

QC procedures included the following:

- All equipment was warmed up for a minimum of 10 minutes before any data were acquired.
- Sensor positioning, within ±1 inch (2.54 centimeters), was confirmed at the beginning of each survey day.
- Personal testing was performed each time the sensor was assembled, typically at the beginning of each survey day, with responses within three standard deviations of the static background. All data were within metrics.
- Cable Connection Vibration testing was performed each survey day. Sensor signals were monitored for shake-induced offsets and no data spikes (<1.0 parts per thousand [ppt]) during the cable shake. All data were within metrics.
- The static background and response over an object was recorded at the beginning and end of each survey day. The inphase component repeatability metric is responses are within ±10% from test to test. All tests were within metrics.

Data Processing Quality Control

Data processing QC metrics were tracked daily throughout the life of the project. QC measures were not only performed on the QC instrument function tests, but also on the project production data collected by the EM31-MK2. The following parameters were analyzed:

- Coverage – 90% of the data had a cross track spacing of 5 ft unless obstructions existed. The data were within the coverage metrics.
- Sample Separation – 95% of the data were spaced no greater than 2 ft along a track. All data were within metrics with an average percentage failed of 0.1%.

Digital Data Processing

Data processing was done in accordance with the methodology outlined in the Geophysical Investigation Plan (GIP), included in the 2015 QAPP (WESTON, 2015a). Processing parameters are listed in **Table 4-1**, below.

Table 4-1
DGM Data Processing Parameters

Process	Parameter
Drift – Non-Linear Drift Correction Filter (UCEDRIFT.GX)	Window Length: 100 % lowest values ignored: 10% % highest values ignored: 70% Inphase Channel processed using these parameters.
Latency Correction	Latency value of 0.3 applied to remove chevron effects
Grid	Cell Size: 0.0762 meter Blanking Distance: 0.9144 meter Search Radius: data mean
Anomalous Areas Review	Performed

Prior to evaluating potential subsurface features, surface features were identified on the base map to differentiate between anomalous readings coinciding with surface debris and those coinciding with buried conductive materials. The plots were also interpreted with regard to site soil characteristics, site-specific geology, and the expected locations of potential waste anomalies.

Anomalies identified as part of the DGM survey were discussed with an anomaly review board, consisting of U.S. Army Environmental Command (USAEC), Fort Bliss, and USACE representatives. Based on the discussion of the anomaly locations, smaller areas with characteristics of potential burial pits and trenches within the AOIs were selected for further evaluation using GPR, as described in Subsection 4.1.4. These smaller areas are referred to in this report as areas of concern (AOCs). Results of the DGM survey are discussed in Section 4.2.

4.1.3 Surface Gamma Radiation Survey

A surface gamma radiation survey was completed to identify locations across the four AOCs where radiation levels exceed background levels and indicate potential presence of radioactive contaminants. The gamma survey focused primarily on gross gamma emitters, highly enriched uranium (HEU) and Cs-137 thought to be present in the potential LLRW. Transuranic isotopes (such as plutonium) or depleted uranium (consists primarily of U-238) have weak gamma emissions and were not evaluated during the gamma survey. In accordance with the approved Work Plan, the assessment was based on strong gamma emitter Cs-137 due to ease of detection.

Background gamma count rates in counts per minute (cpm) were collected from 20 locations of the surface soil in the southwest corner of the Snake Pit Site that are believed to have no apparent

prior involvement with potential waste burial activities nor the presence of past radiological materials. A survey investigation level (IL) was calculated for comparison to survey results using the average background reading plus three times the standard deviation of the background level. The IL calculation is shown on **Table 4-2**. The locations of the background readings are shown on **Figure 2-2**.

Table 4-2
Surface Gamma Survey Investigation Level

Parameter	Value (cpm)
Average Background Surface Gamma Reading	8,560
Standard Deviation	175
2xStandard Deviation	350
3xStandard Deviation	525
Investigation Level	**9,085**
2xAverage Background	17,121

The survey was completed using a Ludlum 44-10 sodium iodide (NaI) detector with a Ludlum 2221 ratemeter. The radiological equipment was coupled with a Trimble GPS device to geo-reference the locations of the data collected during the survey. The gamma radiation survey was conducted using approximately 10-ft transects, with the detector held approximately 24 to 36 inches above ground surface. Readings were collected from the four AOIs described in Section 2 as part of the surface survey activities conducted in June 2015. In addition to the AOIs, the surface of the arroyo was scanned during the April 2016 event to verify that the arroyo soil/sediment had not been impacted by AOI 4 (**Figure 2-2**).

Results from the surface gamma scan were considered elevated and would warrant further investigation if readings exceeded twice the average background concentration. Readings from the gamma scan were considered anomalous if they exceeded the IL [average background radiation level plus three standard deviations (3 sigma)]. Anomalies identified as part of the surface gamma radiation survey were also compared to the EM31-MK2 survey results to identify overlaps in anomalous areas. Results were further discussed with the anomaly review board to select the smaller AOCs for further evaluation using GPR, as described in Subsection 4.1.4. Results of the surface gamma radiation survey are discussed in Section 4.2.

4.1.4 Ground Penetrating Radar Survey

The AOCs that were selected by the anomaly review board were evaluated using GPR. The GPR survey was performed using a Geophysical Survey Systems, Inc. (GSSI) SIR 3000 System GPR unit. The SIR 3000 System is a multi-channel unit that automatically displays, processes, and records cross-sectional, variable color profiles of subsurface materials. The GPR data were used to confirm and enhance the definition of the identified EM anomalies and obtain depth information.

The GPR method uses high frequency radio waves to acquire subsurface information. Short pulses of electromagnetic energy are radiated downward into the subsurface from a transmitting antenna. A portion of the energy is reflected back to a receiving antenna when encountering a layer or object of differing physical properties. A control unit continuously processes variations in the reflected signal, which is then graphically displayed on the onboard computer monitor. The amplitude and frequency of the reflected signal are caused by variations in electrical properties of subsurface materials. These variations result from the varying dielectric properties of the subsurface material and may indicate changing lithology, moisture content, salinity, and structure. Man-made objects such as utilities, UST's, buried debris, and other emplaced objects also produce significant changes in the electrical properties.

The GPR system was calibrated to the materials underlying the area prior to implementation of the survey. In general, to calibrate the system, either the dielectric constant of the survey medium, or the depth to a particular buried object or interface, must be known. For this survey, GPR system was field-calibrated using an averaged dielectric constant for the survey medium. Based on known geologic and site conditions, a dielectric constant of 4.0 was calculated for the soils underlying the site. The data collection rate was set to 80 samples per second to ensure that 5 scans per metric foot were met with any normal walking pace while surveying.

The GPR survey profiles were referenced to the same UTM coordinates established for the site from the EM survey. GPR surveying was accomplished by traversing areas where EM/gamma survey anomalies were identified. Anomaly coordinates from the EM survey were uploaded into the GPS unit to navigate to the EM anomaly locations. The selected AOCs were surveyed using a 400-MHz GPR antenna. Polygons outlining the shapes of selected areas and selected lines

passing through these areas were loaded onto the GPS unit prior to surveying. End points of these lines were navigated to using the GPS and marked with pin flags. Additional lines were added in the field between the surveys lines that were already marked in the GPS at the discretion of the field team. The end points marked by flags in each area were recorded in the GPS at the conclusion of surveying that area. Small plastic cones were set along the survey lines at 10-ft intervals between the pin flags marking the end points. Surveys were completed in straight lines from one flagged end point to the other. The cones served as fiducial markers and were recorded in the GPR as the unit crossed them during the survey.

The procedures outlined in the work plan for QC of the EM-31 could not be used for QC tests of the GPR due to differences in the function of the equipment. Instead prior to the survey, a steel rod was placed 6 inches below the ground, and the GPR was run over the rod in a perpendicular direction. The same QC was performed after the survey.

The GPR surveys were performed at 2 ft to 5 ft line spacing across each anomaly location selected for further evaluation. Maximum depth of the GPR survey at the Snake Pit Site was approximately 1.25 meters (4 ft). The product of the GPR survey is a series of real-time subsurface field profiles. GPR data was stored in memory and later downloaded from the GPR system to a field laptop computer. The data was then post-processed and analyzed using Radan software. Post-processing in Radan 7 included automated background removal and adjusting time zero for each profile based on the location of the first response in the radargram.

Objects with varying electrical characteristics determine the amplitude and velocity of the reflections. Radar anomalies are typically in the form of hyperbolic diffraction patterns, high amplitude horizontal reflectors, or chaotic reflectors. Hyperbolic waveforms are indicative of point source objects such as pipes, USTs, utility conduit, and discrete metal objects. High amplitude horizontal reflectors are indicative of subsurface layers such as buried structure, foundations, fill material, and/or soil layers of high moisture content. Chaotic reflectors are typically associated with heterogeneous or mixed fill material. Results of the GPR survey for each AOI are discussed in Section 4.2.

4.2 SURFACE SURVEY RESULTS

As previously discussed, anomalies noted during the surface gamma and EM surveys were discussed with the anomaly review board 9 June 2015 to identify smaller AOCs within each AOI for further evaluation with GPR. Readings from the surface gamma and EM surveys are shown on **Figures 4-1** through **4-12**. The GPR survey was conducted on these smaller AOCs to further identify anomaly characteristics. GPR profiles for each transect are included in **Appendix B**. Results from the GPR survey were discussed during a 20 August 2015 meeting with the anomaly review board to select AOCs for subsurface gamma survey activities. The subsurface gamma survey is further discussed in Section 4.3 and 4.4. A summary of findings for the AOIs is presented in the following subsections.

4.2.1 AOI 1 Surface Survey Results

Approximately 9.93 acres were surveyed using the EM31-MK2. Areas excluded from the survey included the storage igloos and areas of dense brush. EM terrain conductivity measurements vary throughout the site, suggesting the presence of metallic debris in the subsurface and varying soil types and moisture conditions. Gradual variations (increases or decreases) in the background conductivity typically represent gradational changes in the soil composition and moisture content. Abrupt changes or steep conductivity gradients are typically associated with buried fill material or cultural features.

Average background inphase response values at AOI 1 ranged from -0.0 to 0.25 (ppt) and are shown on **Figure 4-1**. Positive responses within AOI 1 shown as red to pink color contours are predominantly responses from cultural features such as fences, buildings, and signs. A linear feature was identified as a potential buried utility. A negative response shown as a dark blue color was recorded in the northeast corner of the AOI, associated with the residual slab of Building 11508.

Quadrature (apparent conductivity) readings collected from AOI 1 are shown on **Figure 4-2**. Average background conductivity measurements range from approximately 18 millisiemens per meter (mS/m) to 35 mS/m. Response readings were recorded up to 208 mS/m, primarily as result of close proximity of fence lines and structures. Seven AOCs were identified within AOI

1 as a result of the EM survey (**Figure 4-1**). Anomalies were primarily identified in the central and western portions of the AOI.

Surface gamma results were recorded up to 10,102 cpm and are shown on **Figure 4-3**. The majority of anomalous readings were collected from the western half of the AOI. An anomalous gamma reading was recorded within AOC-1-6. Anomalous gamma readings were not recorded within the other AOCs. Anomalous gamma readings were not recorded at levels considered elevated when compared to background levels (exceeding twice the background concentration).

Seven AOCs (AOC-01-01 through AOC-01-07) within AOI 1 were selected for further evaluation using GPR (**Figure 4-1**). Although elevated gamma readings were not recorded from AOC-01-05, this AOC was selected for further evaluation using GPR based on the size of the anomaly detected during the EM survey. Rationale for selection of AOCs for investigation using GPR is provided in **Table 4-3**.

Table 4-3
GPR Survey Rationale – AOI 1

AOC	Rationale for GPR Survey Selection
AOC-01-01	Quadrature and inphase responses above background
AOC-01-02	Inphase response above background; isolated lows; characteristic of smaller buried metal objects
AOC-01-03	Quadrature and inphase responses above background
AOC-01-04	Inphase response above background; isolated lows
AOC-01-05	Large area of inphase above background with potential unknown/suspected utility
AOC-01-06	Large area of conductivity values above background with a suspected/unknown utility
AOC-01-07	Steep inphase gradient changes over unknown and suspected utility across several lines of data; Shift in conductivity values surrounding suspected/unknown utility; AOC not selected for GPR survey

Profiles from the GPR survey are presented in **Appendix B**. Although discontinuities were identified in the GPR surveys, these areas did not correlate with anomalous readings from the EM-31 survey or surface gamma survey. The areas were not thought be associated with buried debris, and no AOCs were selected by the anomaly review board for subsurface gamma survey within AOI 1.

4.2.2 AOI 2 Surface Survey Results

Approximately 6.51 acres was surveyed at AOI 2. An approximately 1-acre area was not surveyed because of structures and areas of dense brush. Average background inphase response readings at AOI 2 ranged from 0.0 to 0.5 ppt and are shown on **Figure 4-4**. The dark blue and violet to red color contours within AOI 2 are predominantly responses from cultural features such as light posts, power lines, signs, tanks, structures, and buried metallic objects. Quadrature (apparent conductivity) readings collected from AOI 2 are shown on **Figure 4-5**. Average background conductivity measurements across AOI 2 as it relates to geology are in the range of 18 mS/m to 32 mS/m. Response readings were recorded from 7.0 mS/m to 11.8 mS/m. Two AOCs (AOC-02-01 and AOC-02-02) were identified in the southeast portion of AOI 2.

Surface gamma results from AOI 2 were recorded up to 10,124 cpm (**Figure 4-6**). The highest reading (10,124 cpm) was recorded in AOC-02-01. Anomalous surface gamma readings were also recorded on the eastern boundary of AOC-02-02. Anomalous gamma readings were not recorded at levels considered elevated compared to background levels (exceeding twice the background concentration).

The GPR survey at AOI 2 was conducted at the two AOCs shown on **Figure 4-6**. Rationale for selection of AOCs for investigation using GPR is provided in **Table 4-4**.

Table 4-4
GPR Survey Rationale – AOI 2

AOC	Rationale for GPR Survey Selection
AOC-02-01	Significant steep gradient changes on both components across several lines of survey; buried trench characteristic; no cultural or surficial features identified during EM survey
AOC-02-02	Gradient change on inphase; isolated trough; characteristic of smaller buried metal objects

Profiles from the GPR survey are presented in **Appendix B**. A high amplitude layer coincident with elevated EM response was identified at AOC-02-01. The anomaly appears to be approximately 0.5 meter deep and extends horizontally approximately 25 meters. Therefore, AOC-02-01, was selected for further evaluation with subsurface gamma survey. Descriptions of the subsurface gamma survey activities and results are presented in Sections 4.3 and 4.4, respectively.

Two smaller high amplitude layers were identified within AOC-02-02. One was identified just below the ground surface, and one was identified approximately 0.75 meter deep. Both anomalies extended horizontally less than 3 meters and did not correlate with anomalous readings from the EM-31 or surface gamma survey; therefore, these areas were not selected for subsurface investigation.

4.2.3 AOI 3 Surface Survey Results

Approximately 9.5 acres were surveyed in AOI 3. Areas not included in the survey were areas of dense brush. Average background inphase response readings at AOI 3 ranged from 0.0 to 0.15 ppt. As shown on the inphase data on **Figure 4-7**, the dark blue (indicating the instrument has reached its peak detection threshold and has "spiked" the instrument) and violet to red color contours (negative and positive values, respectively) are indicative of metallic objects primarily associated with the fence line. A linear feature in the central portion of AOI 3 is thought to be associated with an underground utility.

Quadrature (apparent conductivity) readings collected from AOI 3 are shown on **Figure 4-8**. Average background conductivity measurements range from approximately 11.3 mS/m to 23 mS/m. Varied response readings were recorded with lows to 5.63 mS/m. The EM survey identified one AOC (AOC-03-01) along the northern fence line that displayed steep gradient changes on the inphase and quadrature components.

Surface gamma readings were recorded up to 10,507 cpm (**Figure 4-9**). The highest reading was recorded from the southern boundary of the AOI and did not coincide with AOC-03-01 identified as part of the DGM survey. Anomalous gamma readings were not recorded at levels considered elevated when compared to background levels (exceeding twice the background concentration). The GPR survey location conducted at AOC-03-01 is shown on **Figure 4-9**. Rationale for selection of the AOC for investigation using GPR is provided in **Table 4-5**.

Table 4-5
GPR Survey Rationale – AOI 3

AOC	Rationale for GPR Survey Selection
AOC-03-01	Steep gradient changes on both components; no cultural features identified; close to road.

Based on the results of the GPR survey conducted at AOC-03-01 (shown in **Appendix B**), the anomalous reading identified at AOC-03-01 is thought to be associated with the presence of underground utilities and is not thought to signify the presence of buried radiological waste. Therefore, no areas within AOI 3 were selected for subsurface gamma survey activities.

4.2.4 AOI 4 Surface Survey Results

Approximately 4.4 acres were surveyed at AOI 4. Background inphase response readings at AOI 4 ranged from 0.0 to 0.5 ppt and are shown on **Figure 4-10**. Peak responses recorded from AOI 4 are predominantly associated with cultural features such as signs, barbed wire, metal scrap, and debris. Quadrature (apparent conductivity) readings collected from AOI 4 are shown on **Figure 4-11**. Average background conductivity measurements across AOI 4 as it relates to geology are in the range of approximately 18 mS/m to 27 mS/m. Results of the EM survey identified ten AOCs (AOC-04-01 through AOC-04-10) in various areas throughout AOI 4. An eleventh AOC (AOC-04-11) was also identified for surface gamma survey evaluation only and includes the arroyo south of AOI 4.

Surface gamma readings at AOI 4 were recorded up to 10,070 cpm (**Figure 4-12**) within AOI 4. The highest reading was observed in the northern portion of AOI 4, just west of AOC-04-08 and north of AOC-04-09. As discussed in Section 4.1.3, a surface gamma survey of the constructed arroyo was conducted during a second field event conducted in April 2016. The highest reading was observed near the southern boundary of AOI 4, south of AOC-04-02 (**Figure 4-12**). Anomalous gamma readings were not recorded at levels considered elevated compared to background levels (exceeding twice the background concentration). The GPR survey locations conducted at AOI 4 are shown on **Figure 4-12**. Rationale for selection of the AOCs for investigation using GPR is provided in **Table 4-6**.

Table 4-6
GPR Survey Rationale – AOI 4

AOC	Rationale for GPR Survey Selection
AOC-04-01	Steep gradient changes on both components; no cultural features identified; trench/burial pit characteristics
AOC-04-02	Several isolated lows and highs on inphase; located within higher conductivity soils
AOC-04-03	Steep gradient changes on inphase; characteristic of buried metal

AOC	Rationale for GPR Survey Selection
AOC-04-04	Strong inphase response with slight corresponding change in quadrature response; near drainage swale
AOC-04-05	Both components display good variance from background, potential buried metal; no cultural features identified
AOC-04-06	Linear feature on quadrature; some slightly low values on inphase; no cultural features identified; within guard shack line of sight
AOC-04-07	Quadrature component significantly different from background; changes of soil properties; isolated inphase responses characteristic of buried small metal
AOC-04-08	Isolated inphase responses characteristic of smaller buried metal objects
AOC-04-09	Quadrature component significantly different from background; changes of soil properties; isolated inphase responses characteristic of buried metal; within guard shack line of sight
AOC-04-10	Zone of lower conductive soils located near the drainage swale; potentially fill material

Based on the results of the GPR survey, several anomalous results were identified, including discontinuities, chaotic layering, and high amplitude layers. Results from the GPR survey are presented in **Appendix B**. As described in Section 2, approximately 8 ft of fill was placed at AOI 4 following construction of the arroyo adjacent south of AOI 4. Due to equipment limitations, results of the surface surveys are believed to only characterize fill material. Based on the uncertainties associated with the anomalies identified during the surface surveys, AOI 4 was selected for subsurface gamma evaluation.

4.3 SUBSURFACE GAMMA SURVEY DESCRIPTIONS

Results of the surface surveys were discussed with the anomaly review board 20 August 2015 to select locations for further investigation to include a subsurface gamma survey. Based on the results of the surface surveys, 10 boreholes were installed in anomalous areas described in Section 4.2 (**Figure 4-13**). Three borings were completed in AOI 2 (AOC-02-01-01, AOC-02-01-02, and AOC-02-01-03), an area selected by the anomaly review board for focused subsurface investigation based on anomalous results from the surface surveys. Seven borings were completed in AOI 4 (AOC-04-03-01, AOC-04-05-01, AOC-04-07-01, AOC-04-08-01 AOC-04-08-02, AOC-04-09-01, and AOC-04-09-02) in areas selected by the anomaly review board based on anomalous readings and the uncertainty of the surface survey results due to the presence of fill at the surface. In addition, two background borings (SP-BG-01 and SP-BG-02) were completed to 20 ft bgs in the background reference area, in the same general vicinity as the background surface gamma readings (**Figure 2-2**).

Boreholes were completed with a 9-inch hollow stem auger, and core samples were collected in 5-ft intervals. Core samples were screened for radioactivity and logged to determine lithology changes. Boreholes were completed to either: 1) a maximum of 20 ft bgs of native material had been encountered as determined by the onsite geologist; or 2) 40 ft bgs, which was based on historical information obtained for the site. A 2-inch polyvinyl chloride (PVC) pipe was placed into each boring hole, and subsurface gamma measurements were collected at 1-ft intervals with a Ludlum 44-62 NaI detector coupled with a Ludlum 2221 scaler meter.

Subsurface gamma readings were compared to action levels that were determined by averaging corresponding depth intervals for the two background borings and adding three standard deviations. Action levels for each 1-ft interval and the results of the subsurface gamma scanning for each boring can be found in the **Appendix C**. Action levels were only compared to readings collected from areas determined to be similar to background and undisturbed soil.

Soils recovered from each boring location where subsurface gamma readings were above action levels were also scanned at the surface with a Ludlum 44-10 NaI detector coupled with a Ludlum 2221 rate meter. All fill material and disturbed soils were scanned for areas exceeding two times background in the subsurface and in the soils recovered at the surface. Subsurface gamma measurements were counted for two minutes (cp2m) to increase the sensitivity of the measurements. Once gamma subsurface surveys were completed, the 2-inch PVC was removed from the ground, and the boring location was backfilled with the material removed from the hole.

4.4 SUBSURFACE GAMMA SURVEY RESULTS

Subsurface gamma measurements exceeded the action levels set for multiple intervals from each boring. Observations of the subsurface gamma readings showed increased gamma measurements within areas of different types of sediment and geometric changes, depending on the location of the detector within the boring. Due to the detectors changing geometry within each boring, gamma readings were observed to increase as the detector became closer to the base of the boring because of increased gamma radiation contribution from the soil at the base of the boring. However, all of the subsurface gamma measurements appeared to be within the natural variability of each sediment type when compared to background measurements. The subsurface

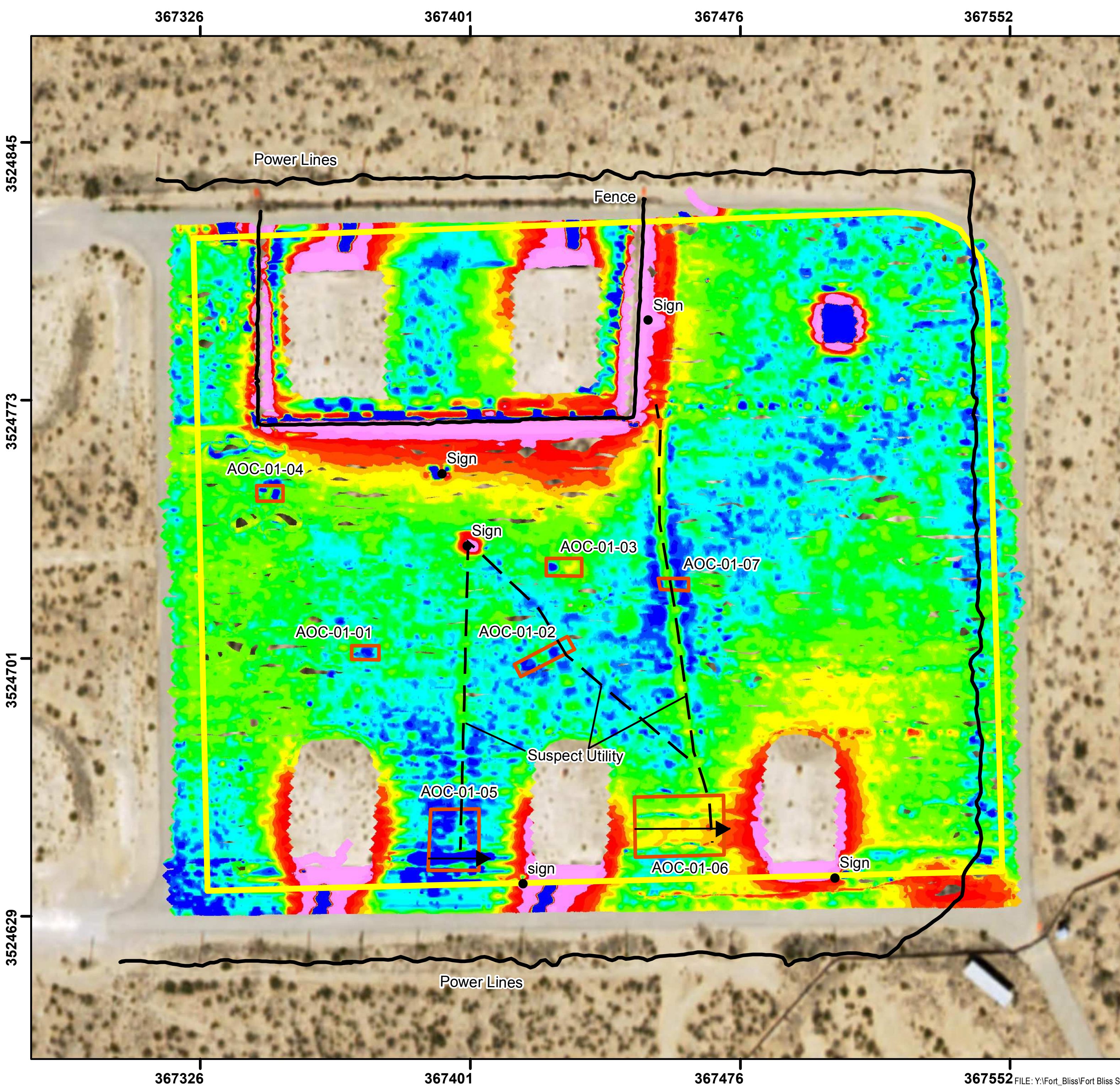
measurements are included in Appendix C which include the action levels for each interval and the observed count rates.

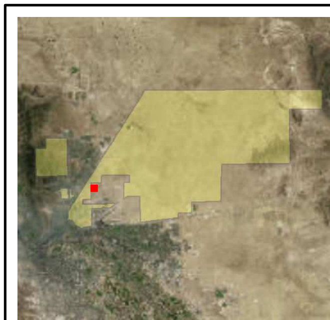
Subsurface gamma measurements within the fill material appeared to have the same variability as the native soils. All fill material observed in the borings was scanned at the surface with the 2x2 NaI detector, and no measurements exceeded two times the average background count rate. No foreign materials within the fill material or presumed natural lithology were encountered in any of the borings to indicate that items were buried within the boring diameter. Although many subsurface measurements exceeded the action levels, no surface readings of the soil collected from the borings exceeded two times the average background count rate. None of the borings appeared to have any anomalous radiological areas. However, many areas of disturbed soils were observed in the areas thought to have been locations where the radiological materials were buried.

A summary of the findings at each boring location is presented in **Table 4-5**. As previously discussed, AOC-02-01 was selected for focused subsurface investigation based on anomalous results from the surface surveys. A summary of results for AOC-02 from all surveys associated with the PA is presented in Figure 4-14. Boring logs are included as **Appendix A**.

Table 4-7
Subsurface Gamma Survey Results Summary

Boring Location	Total Boring Depth (ft-bgs)	Highest Gamma Reading (cp2m)	Depth of Highest Gamma Reading (ft-bgs)	Findings
Background				
SP-BG-01	20	3,120	13	Background location
SP-BG-01	20	3,182	19	Background location
AOI 2				
AOC-02-01-01	22	3,651	17	The upper foot of soils appeared disturbed. No foreign materials were encountered in the boring.
AOC-02-01-02	21	3,147	16	The upper foot of soils appeared disturbed. No foreign materials were encountered in the boring.
AOC-02-01-03	21	3,124	11	The upper foot of soils appeared disturbed. No foreign materials were encountered in the boring.
AOI 4				
AOC-04-09-01	30	3,699	30	The boring location appeared to have 11 ft of fill material thought to have been related to the enlargement of the drainage pathway or previous soil disturbance activity in the area. No foreign materials were encountered in the boring.
AOC-04-09-02	30	3,933	27	The boring location appeared to have 10.5 ft of fill material thought to have been related to the enlargement of the drainage pathway or previous soil disturbance activity in the area. No foreign materials were encountered in the boring.
AOC-04-08-01	30	4,068	28	The boring location appeared to have 10.5 ft of fill material thought to have been related to the enlargement of the drainage pathway or previous soil disturbance activity in the area. No foreign materials were encountered in the boring.
AOC-04-08-02	20	3,395	19	Boring location was moved approximately 20 ft to the east due to boring selected location being inaccessible to the drilling rig and unsafe for the drill crew. Additionally, the boring location was located off the eastern edge of the fill material from the drainage pathway. Soils appeared to be disturbed to 6 ft from previous soil disturbance activities. No foreign materials were encountered in the boring.
AOC-04-05-01	30	3,016	28	Boring location is near the northern extent of the fill material and appears to have minimal amount of soil disturbed beneath the fill material No foreign materials were encountered in the boring.
AOC-04-07-01	30	3,473	28	Boring location is in the center of the fill material and appeared to have some disturbed soils before reaching native soils. No foreign materials were encountered in the boring.
AOC-04-03-01	25	3,395	23	Boring location is on the eastern extent of fill material area with approximately 1 ft of fill before native materials begun. No foreign materials were encountered in the boring.





SOURCE: Esri, World Imagery, 2015

WESTON SOLUTIONS

FIGURE 4-1

AOI 1 EM31-MK2 SURVEY RESULTS
INPHASE COMPONENT
SNAKE PIT SITE
FORMER US BIGGS ARMY AIR FIELD
FORT BLISS. TEXAS

DATE	PROJECT NO	SCALE
JUN 2016	03886.544.012	AS SHOWN

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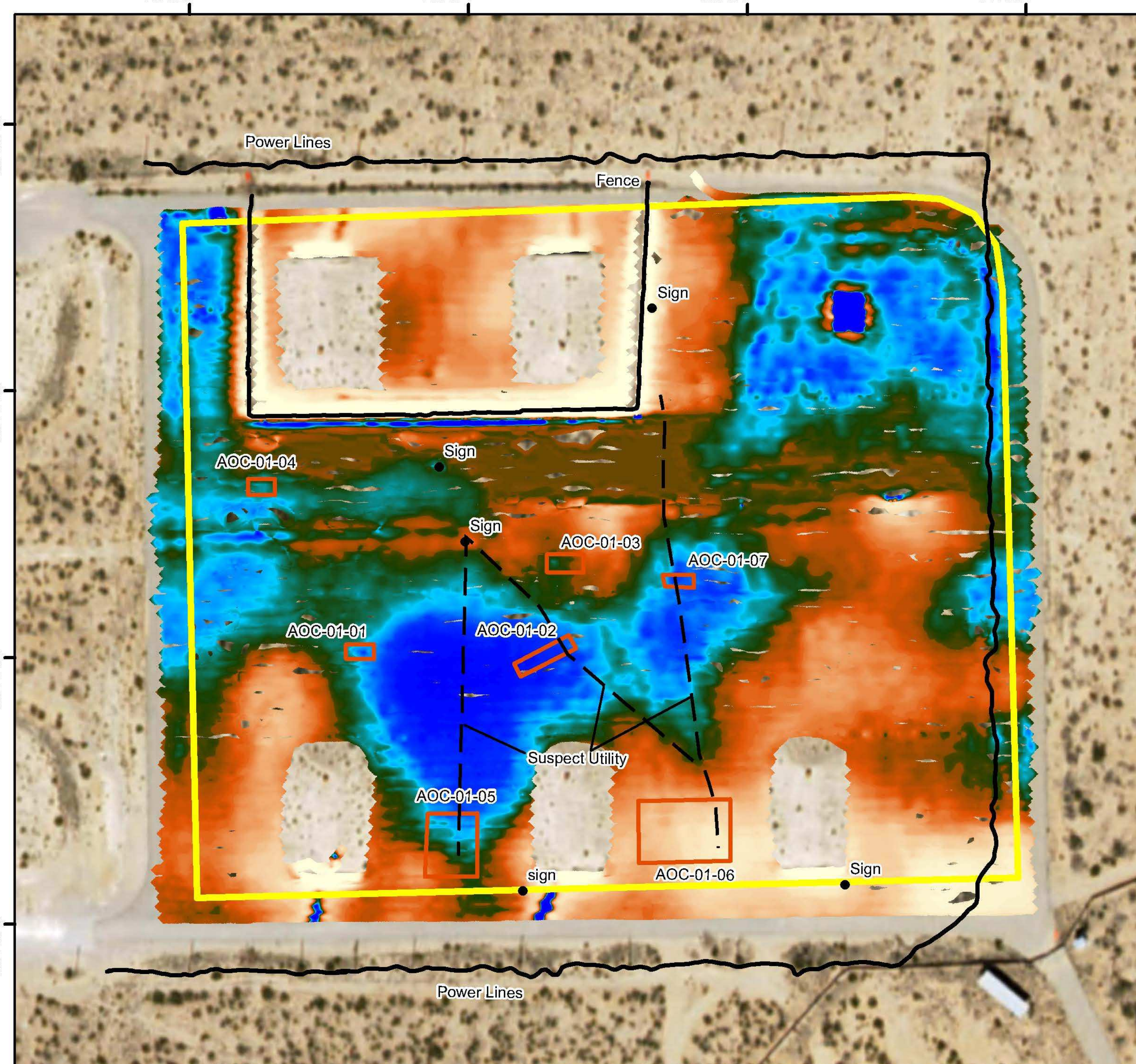
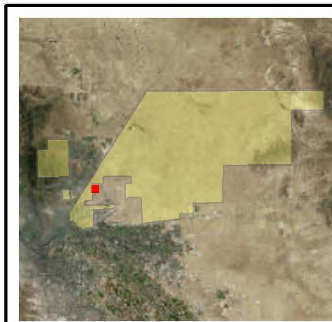
10/03/2018





LEGEND

Areas of Interest

Areas of Concern (AOC)

Fence Line

Cultural Features

9.9 13.8 15.3 16.4 17.6 18.9 20.4 21.2 23.3 26.2 30.2 37.3 70.9

Response (mS/m)

N

0 90 180

Feet

SOURCE: Esri, World Imagery, 2015

WESTON SOLUTIONS

FIGURE 4-2

AOI 1 EM31-MK2 SURVEY RESULTS
QUADRATURE COMPONENT
SNAKE PIT SITE
FORMER US BIGGS ARMY AIR FIELD
FORT BLISS. TEXAS

DATE	PROJECT NO	SCALE
JUN 2016	03886.544.012	AS SHOWN

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10/03/2018

FIGURE 4-3
AOC-1 SURFACE GAMMA
SURVEY RESULTS
SNAKE PIT SITE
FORMER US BIGGS ARMY AIR FIELD
FORT BLISS. TEXAS

DATE	PROJECT NO	SCALE
JUN 2016	03886.544.012	AS SHOWN

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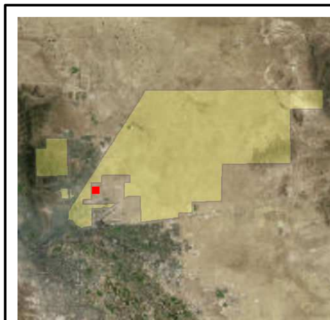
10/03/2018

10/03/2018



LEGEND

Areas of Interest

Areas of Concern (AOC)

Fence Line

GPR Transect Direction

Cultural Features

-0.4 -0.0 0.0 0.1 0.1 0.2 0.3 0.4 0.7 3.3

Response (ppt)

N

0 90 180

Feet

SOURCE: Esri, World Imagery, 2015

WESTON SOLUTIONS

FIGURE 4-4

AOI 2 EM31-MK2 SURVEY RESULTS
INPHASE COMPONENT
SNAKE PIT SITE
FORMER US BIGGS ARMY AIR FIELD
FORT BLISS. TEXAS

DATE	PROJECT NO	SCALE
JUN 2016	03886.544.012	AS SHOWN

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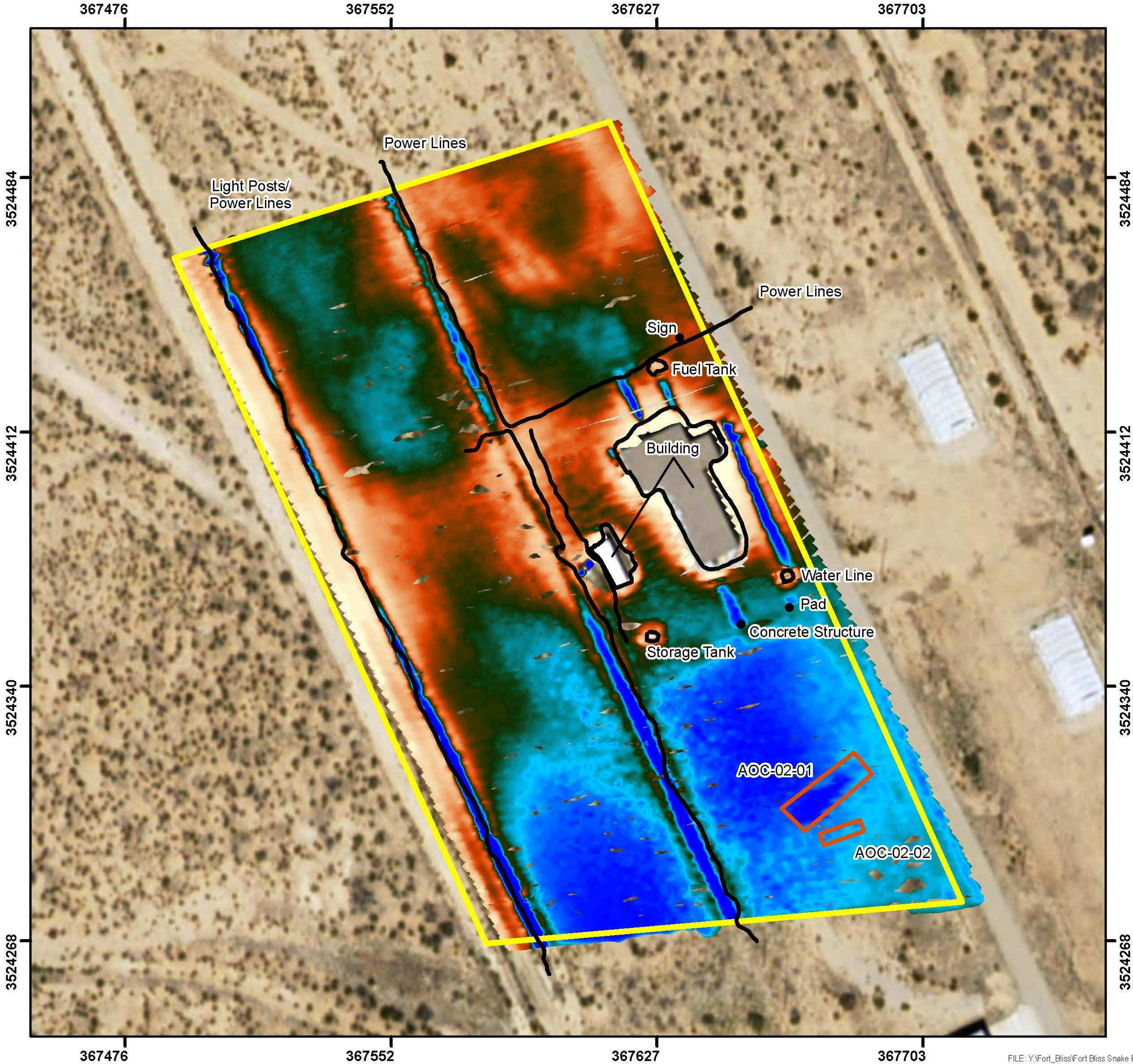

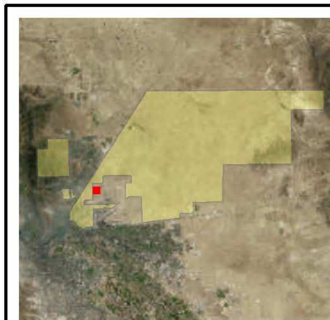

LEGEND

- Areas of Interest
- Areas of Concern (AOC)
- Fence Line
- Cultural Features

3.91 3.8 17.2 20.7 23.8 28.2 32.6 42.5

Response (mS/m)

N

0 90 180

Feet

SOURCE: Esri, World Imagery, 2015

FIGURE 4-5
AOI 2 EM31-MK2 SURVEY RESULTS
QUADRATURE COMPONENT
SNAKE PIT SITE
FORMER US BIGGS ARMY AIR FIELD
FORT BLISS. TEXAS

DATE	PROJECT NO	SCALE
JUN 2016	03886.544.012	AS SHOWN

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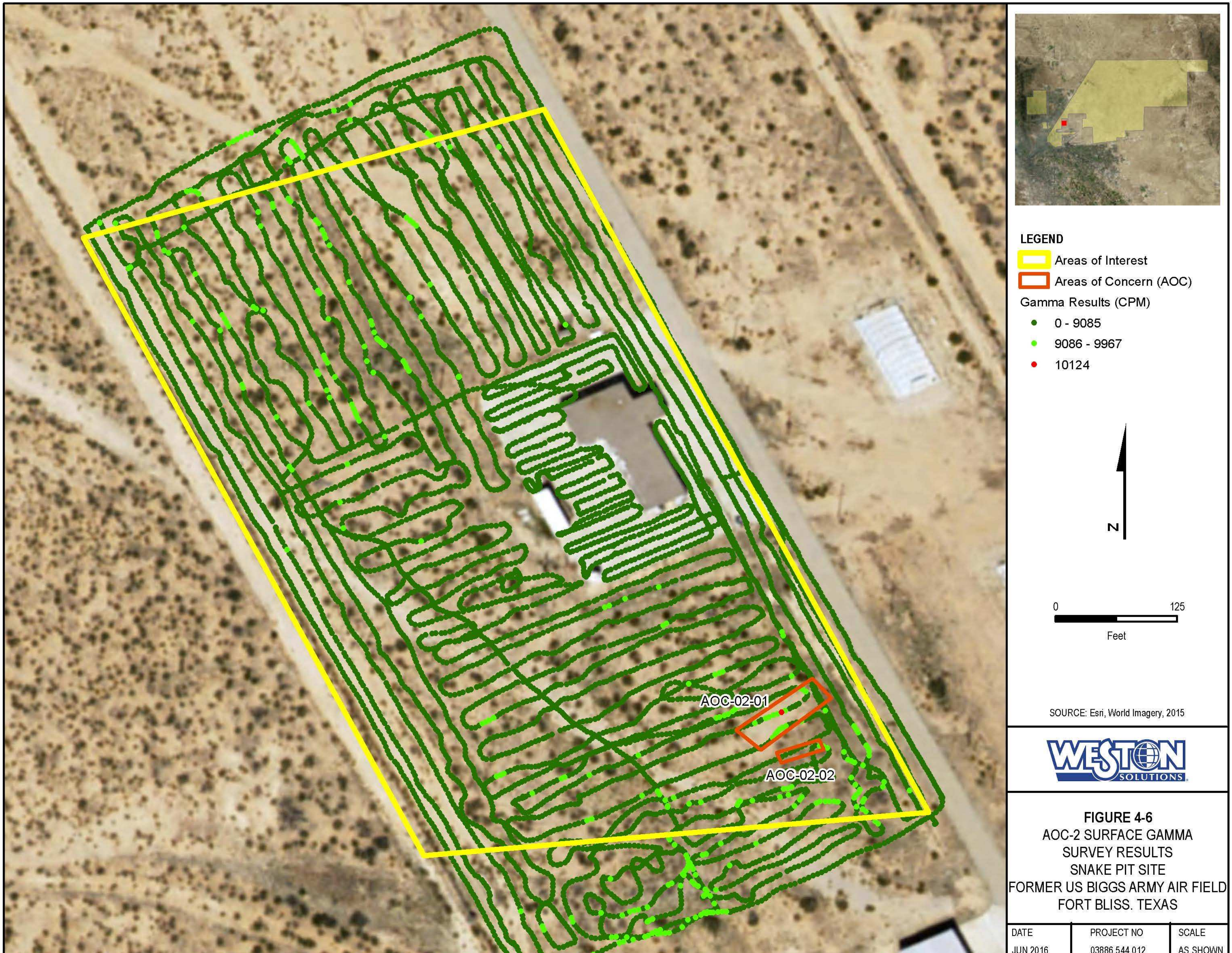

WESTON SOLUTIONS

FIGURE 4-6
AOC-2 SURFACE GAMMA
SURVEY RESULTS
SNAKE PIT SITE
FORMER US BIGGS ARMY AIR FIELD
FORT BLISS, TEXAS

DATE	PROJECT NO	SCALE
JUN 2016	03886.544.012	AS SHOWN

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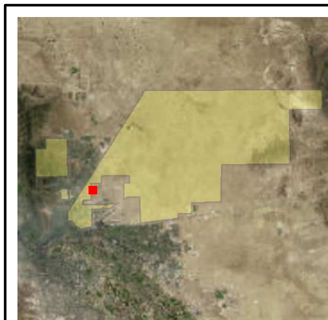
10/03/2018

10/03/2018



LEGEND

- Areas of Interest
- Areas of Concern (AOC)
- Fence Line
- GPR Transect Direction
- Cultural Features

-0.1 -0.0 -0.0 0.0 0.0 0.1 0.1 0.1 0.2 0.3 0.4 0.7 2.4

Response (ppt)

N

0 140 280

Feet

SOURCE: Esri, World Imagery, 2015

WESTON SOLUTIONS

FIGURE 4-7

AOI 3 EM31-MK2 SURVEY RESULTS
INPHASE COMPONENT
SNAKE PIT SITE
FORMER US BIGGS ARMY AIR FIELD
FORT BLISS. TEXAS

DATE	PROJECT NO	SCALE
JUN 2016	03886.544.012	AS SHOWN

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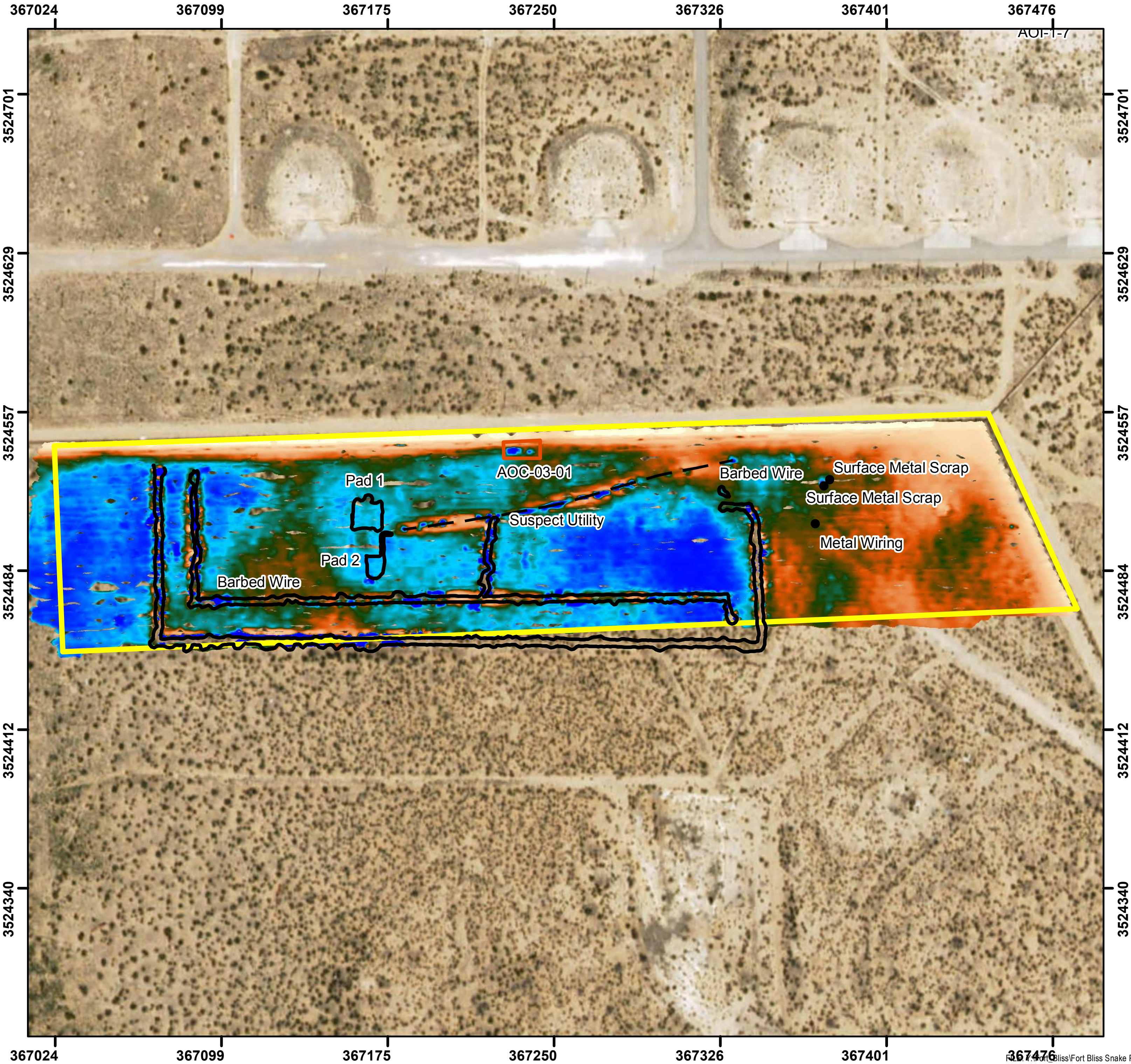

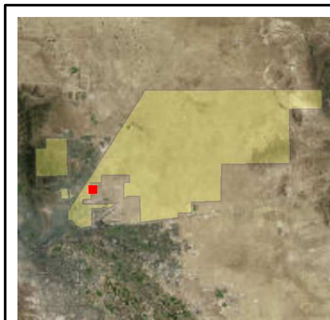

LEGEND

- Areas of Interest
- Areas of Concern (AOC)
- Fence Line
- Cultural Features

-10.4 11.3 12.4 13.3 14.3 15.6 16.9 18.4 23.3

Response (mS/m)

N

0 140 280

Feet

SOURCE: Esri, World Imagery, 2015

WESTON SOLUTIONS

FIGURE 4-8

AOI 3 EM31-MK2 SURVEY RESULTS
QUADRATURE COMPONENT
SNAKE PIT SITE
FORMER US BIGGS ARMY AIR FIELD
FORT BLISS. TEXAS

DATE	PROJECT NO	SCALE
JUN 2016	03886.544.012	AS SHOWN

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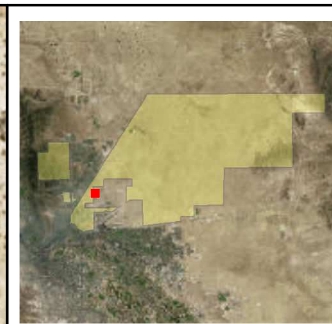

LEGEND

Areas of Interest

Areas of Concern (AOC)

Gamma Results (CPM)

- 0 - 9085
- 9086 - 10365
- 10507

N

0 250

Feet

SOURCE: Esri, World Imagery, 2015

FIGURE 4-9
AOC-3 SURFACE GAMMA
SURVEY RESULTS
SNAKE PIT SITE
FORMER US BIGGS ARMY AIR FIELD
FORT BLISS. TEXAS

DATE	PROJECT NO	SCALE
JUN 2016	03886.544.012	AS SHOWN

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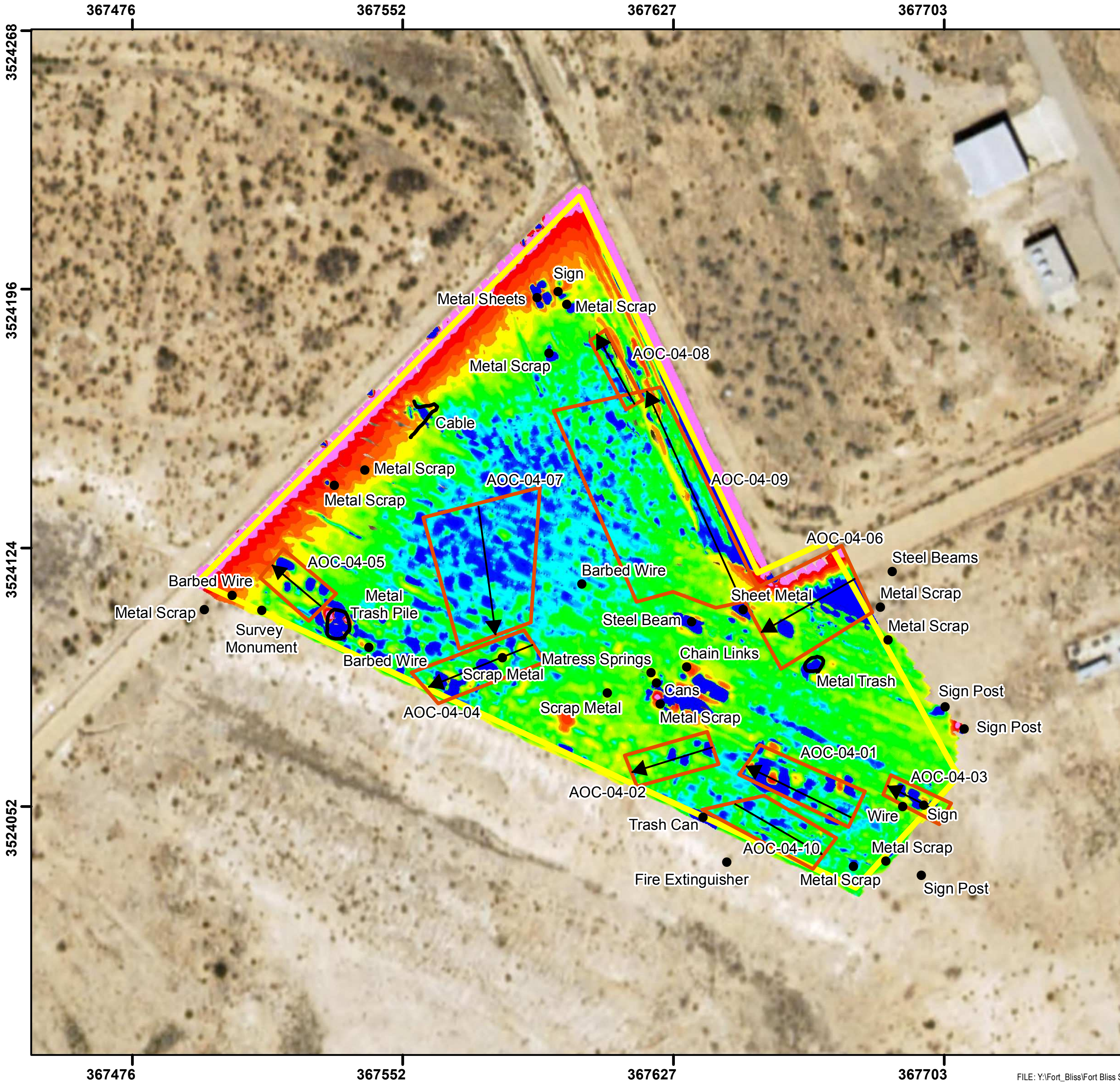
10/03/2018



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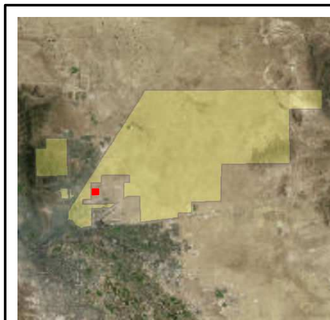

LEGEND

- Areas of Interest
- Areas of Concern (AOC)
- Fence Line
- GPR Transect Direction
- Cultural Features

-0.5 -0.0 0.0 0.0 0.1 0.1 0.2 0.4 1.4

Response (ppt)

N

0 90 180

Feet

SOURCE: Esri, World Imagery, 2015

WESTON SOLUTIONS

FIGURE 4-10
AOI 4 EM31-MK2 SURVEY RESULTS
INPHASE COMPONENT
SNAKE PIT SITE
FORMER US BIGGS ARMY AIR FIELD
FORT BLISS. TEXAS

DATE	PROJECT NO	SCALE
JUN 2016	03886.544.012	AS SHOWN

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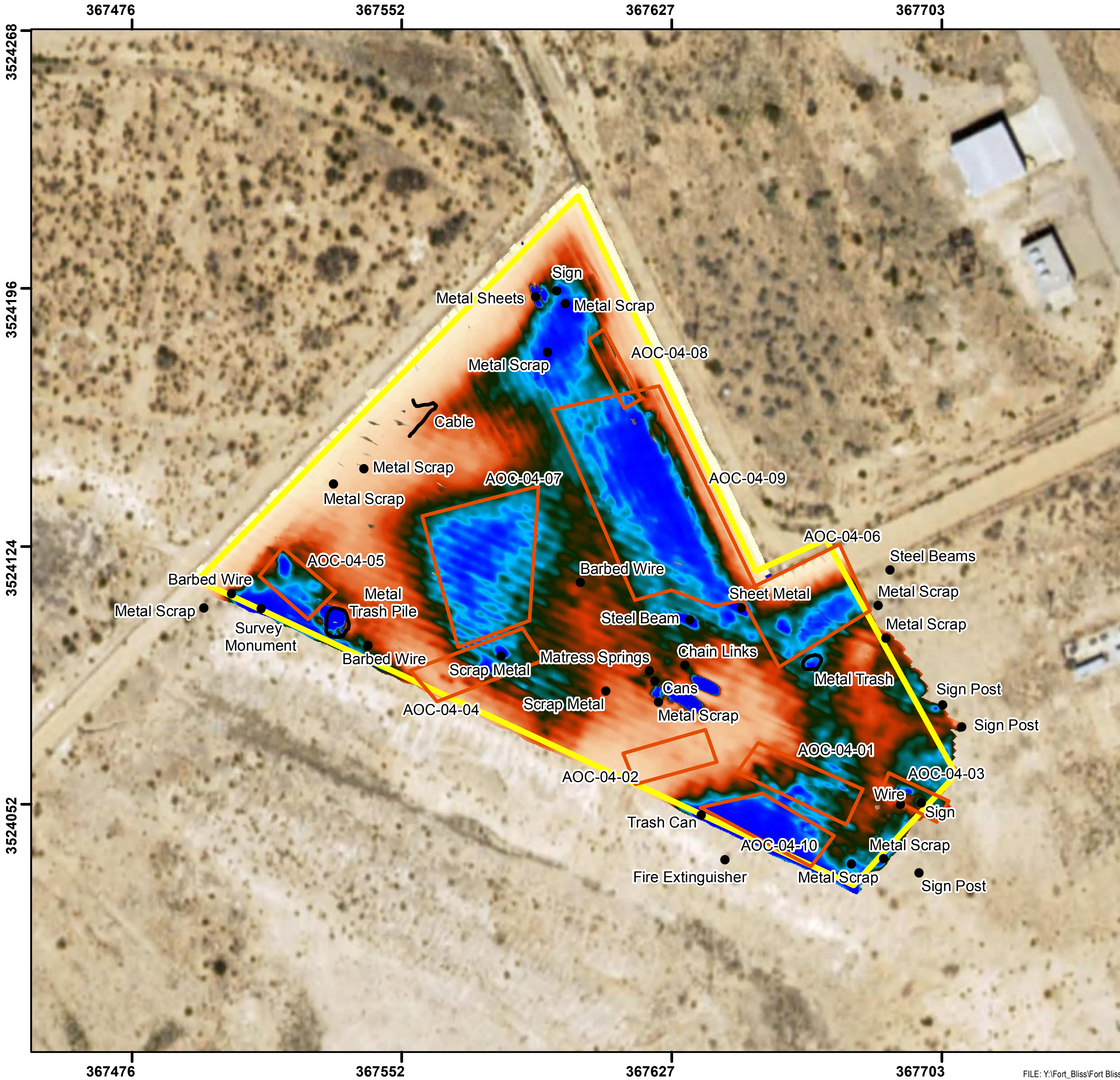

10/03/2018

LEGEND

- Areas of Interest
- Areas of Concern (AOC)
- Fence Line
- Cultural Features

10.0 18.0 19.2 20.3 21.6 23.6 27.7 57.5

Response (mS/m)

N

0 90 180

Feet

SOURCE: Esri, World Imagery, 2015

WESTON SOLUTIONS

FIGURE 4-11

AOI 4 EM31-MK2 SURVEY RESULTS
QUADRATURE COMPONENT
SNAKE PIT SITE
FORMER US BIGGS ARMY AIR FIELD
FORT BLISS. TEXAS

DATE	PROJECT NO	SCALE
JUN 2016	03886.544.012	AS SHOWN

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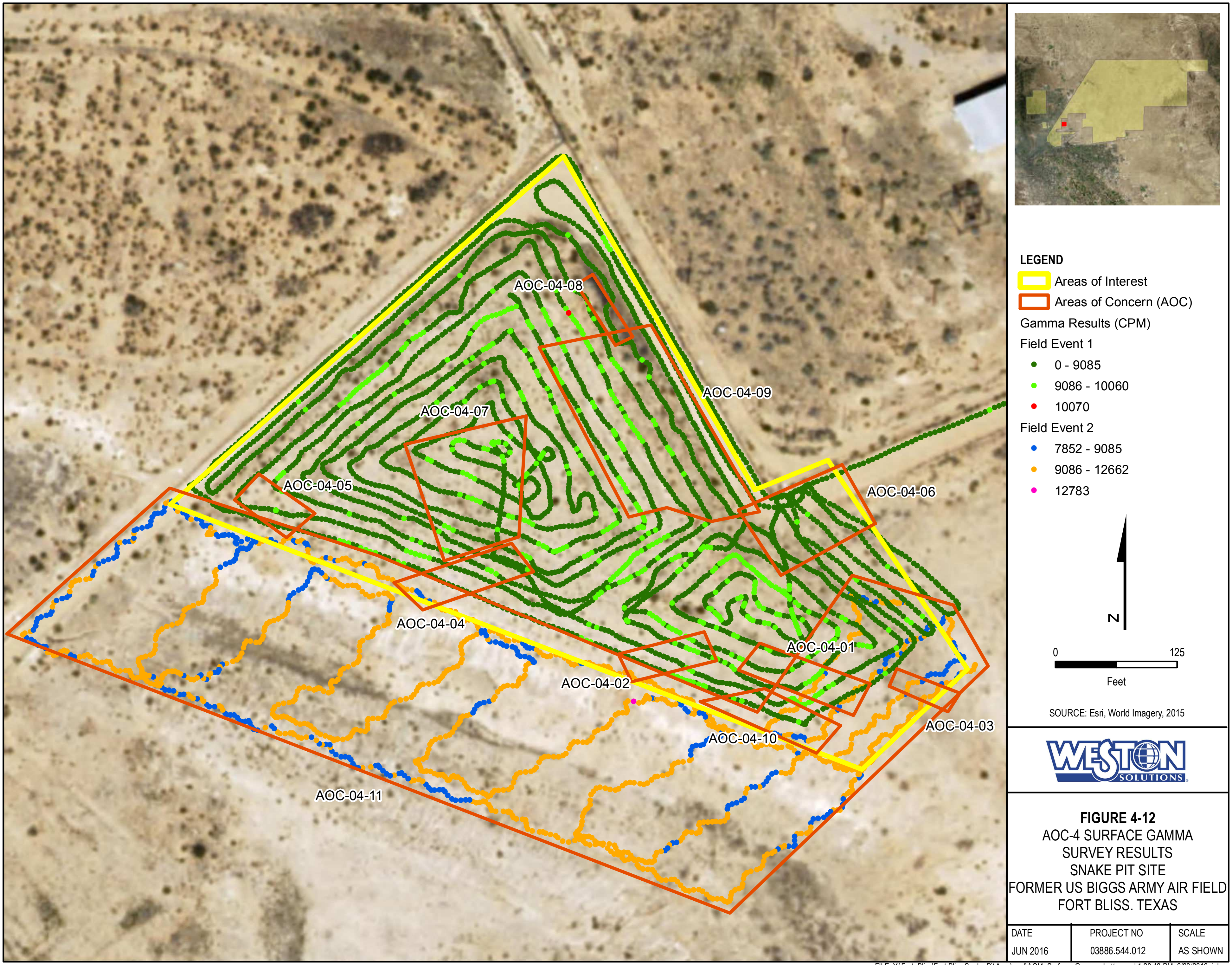

WESTON SOLUTIONS

FIGURE 4-12
AOC-4 SURFACE GAMMA SURVEY RESULTS
SNAKE PIT SITE
FORMER US BIGGS ARMY AIR FIELD
FORT BLISS. TEXAS

DATE	PROJECT NO	SCALE
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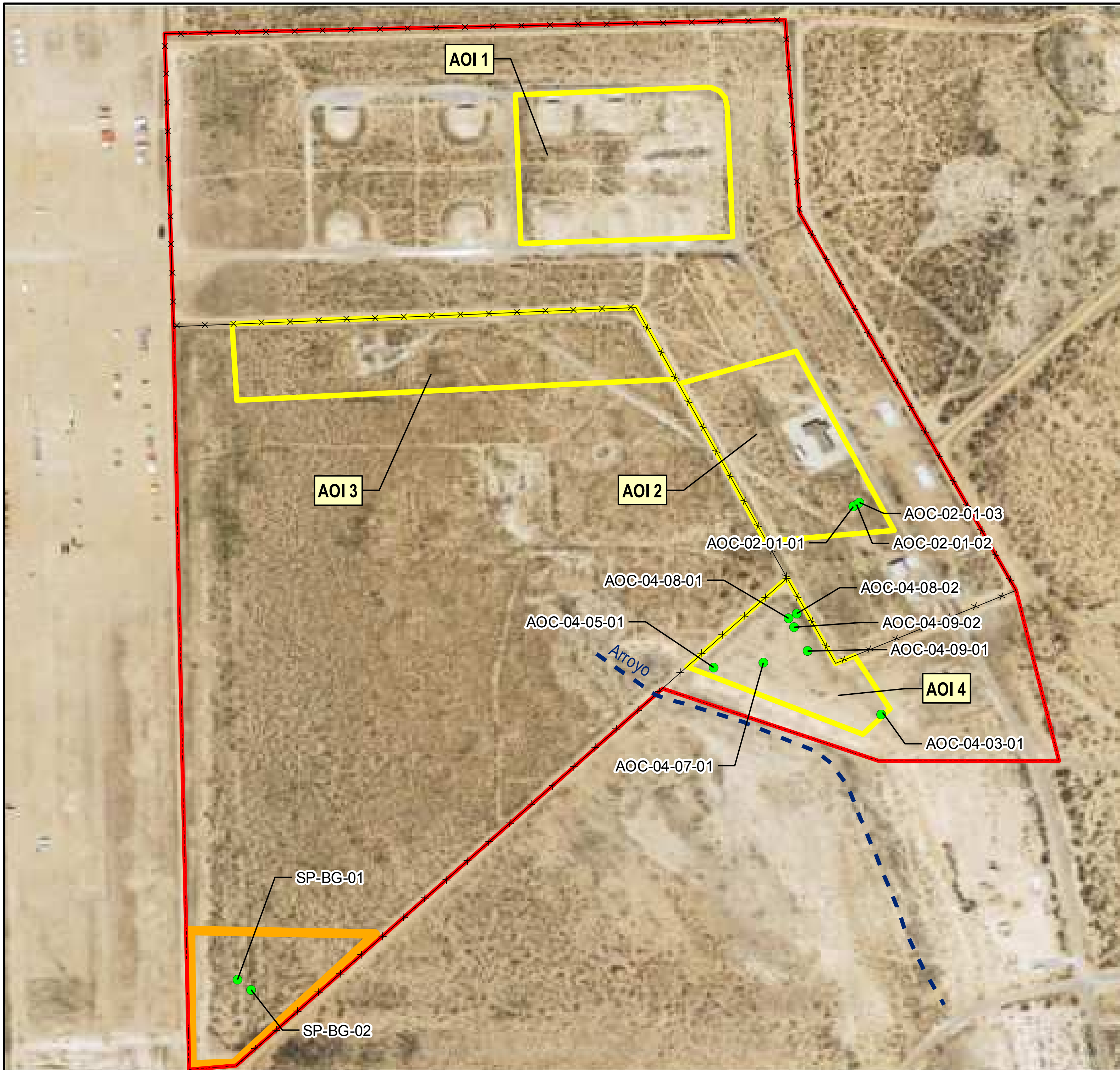


LEGEND

- Snake Pit Area
- Areas of Interest
- Surface Gamma Survey Background Location
- Subsurface Gamma Survey Boring Location
- Historical WSA Boundary Fence

N

0 400 800

Feet

SOURCE: Esri, World Imagery, 2015

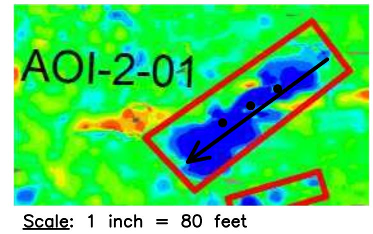
WESTON SOLUTIONS

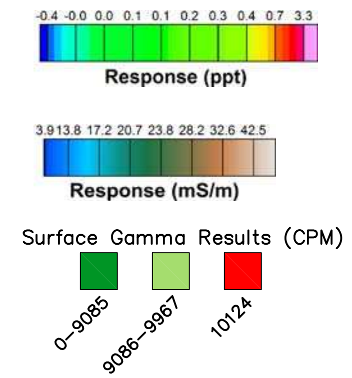
FIGURE 4-13
SUBSURFACE GAMMA
SURVEY BORING LOCATIONS
SNAKE PIT SITE
FORMER US BIGGS ARMY FIELD
FORT BLISS, TEXAS

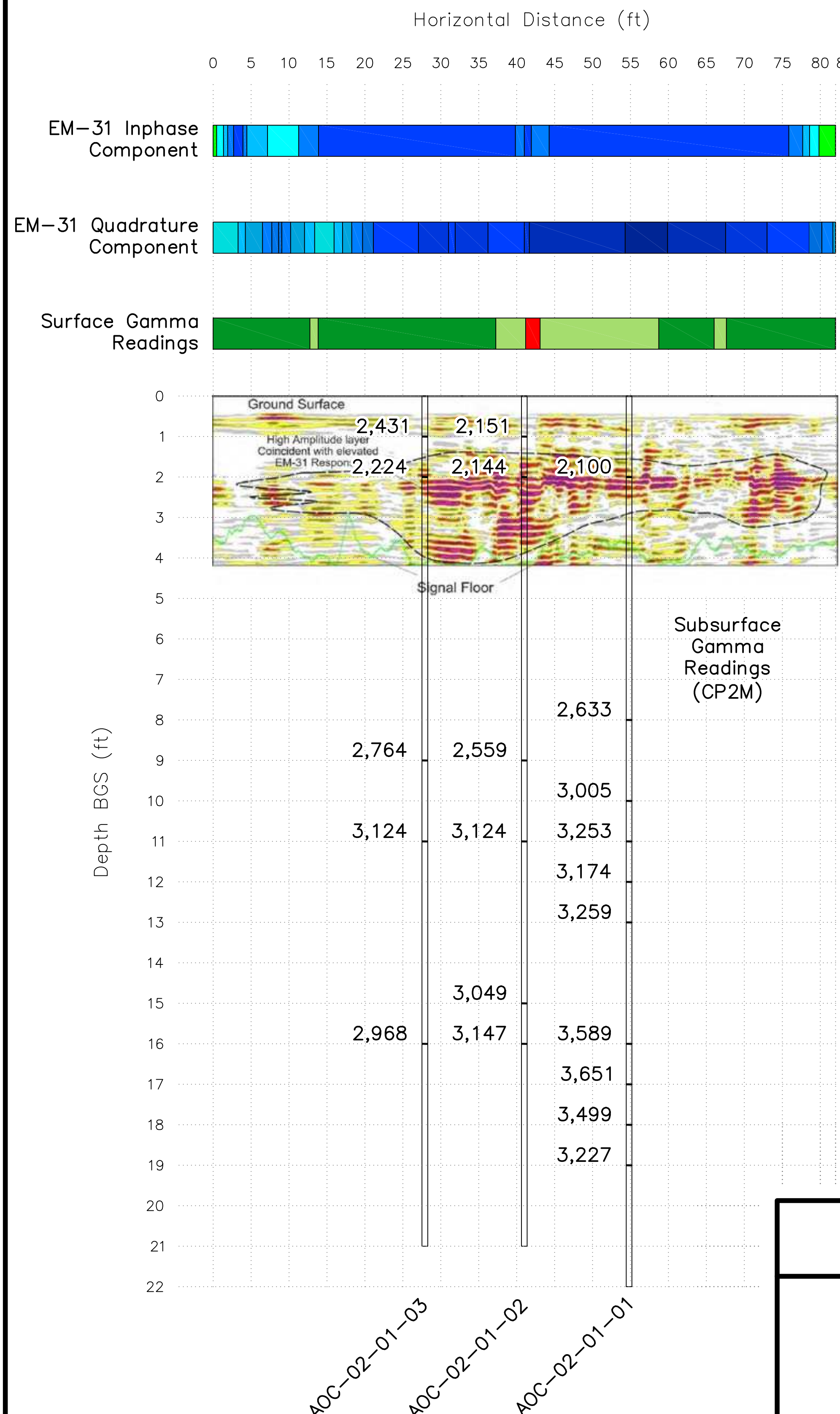
DATE	PROJECT NO	SCALE
JUN 2016	03886.544.012	AS SHOWN

FILE: Y:\Fort_Bliss\Fort Bliss Snake Pit Area\mxd\SubSurface_Gamma_Boring.mxd 1:06:05 PM 6/23/2016 ricksc

10/03/2018







Notes:

1. Subsurface gamma readings below action level are not shown on this figure.
2. No subsurface gamma readings were greater than 2X background.

Units:

ppt	parts per thousand
mS/m	millisiemens per meter
CPM	counts per minute
CP2M	counts per two minutes

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FIGURE 4–14

AOC–02–01 PA RESULTS

SNAKE PIT SITE
FORT BLISS, TEXAS

DATE	PROJECT NO.	SCALE
JUN 2016	03886.544.012	AS SHOWN

June 24, 2016 – 10:27am User: chernicd

H:\Corps_03886\544.012 Snake Pit and CCAD EA\Snake Pit\06.0 Data and Figures\PA Figures\CAD\Figure 4–14 PA Results.dwg Layout: AOC–02–01

10/03/2018

5. SUMMARY AND CONCLUSIONS

A surface gamma survey, EM survey, and GPR survey were conducted at four AOIs located at the Snake Pit Site. Anomalies noted during the surface gamma and EM surveys were used to identify smaller AOCs within each AOI. The GPR survey was conducted on these smaller AOCs to further identify anomaly characteristics. The areas selected for subsurface gamma survey were based on anomalies noted from all three surface surveys. A summary of findings for the AOIs is as follows:

- **AOI 1:** Seven AOCs were identified with AOI 1 and further evaluated with GPR. Based on the findings from the surface gamma, EM, and GPR surveys, no anomalies were identified within AOI 1 for subsurface evaluation.
- **AOI 2:** Two AOCs were identified within AOI 2 and further evaluated with GPR. Based on the surface gamma survey, AOI 2 was selected for further evaluation to include a subsurface gamma survey. Based on the results of the subsurface gamma survey, no readings exceeded twice the background reading.
- **AOI 3:** One AOC was identified within AOI 3 based on the EM survey. The anomaly identified is thought to be associated with the presence of underground utilities and is not thought to signify presence of buried radiological waste. Therefore, no subsurface gamma survey activities were conducted for AOI 3.
- **AOI 4:** Ten AOCs were identified within AOI 4 and further evaluated with GPR. Based on the surface surveys, anomalies appear to be associated with several AOCs within AOI 4. As described in the 2015 UFP-QAPP, approximately 8 ft of fill were placed at AOI 4 following installation of an arroyo that was created adjacent south of AOI 4. Therefore, there are uncertainties associated with the anomalies identified during the surface surveys, and AOI 4 was selected for subsurface gamma evaluation. Subsurface gamma readings were collected from 7 soil borings within AOI 4. Based on the results of the subsurface gamma survey, no readings exceeded twice the background reading.

Six AOCs were selected for subsurface gamma survey as a result of the EM, GPR, and surface gamma surveys. Subsurface gamma readings did not exceed two times background levels. Therefore, further investigation is not recommended.

6. REFERENCES

Fort Bliss, 2013. *Final Environmental Impact Statement for the Implementation of Energy, Water, and Solid Waste Sustainability Initiatives at Fort Bliss, Texas and New Mexico*. Prepared by the United States Army Environmental Command and Directorate of Public Works Environmental Division, Fort Bliss. December 2013.

Fort Bliss, 2014. *Memorandum for Record, Former Biggs AFB WSA Historical Research for Suspected Radiological Burials*. CEMVS-EC-ER. 21 July 2014.

Geonics, Ltd., 1995. Operating Manual for EM31-MK2.

McNeill, J.D., 1980. "Electromagnetic Terrain Conductivity Measurements at Low Induction Number." Technical Note TN-6, Geonics, Ltd., Mississauga, Ontario.

NRCS (Natural Resources Conservation Service), 2016. Web Soil Survey, NRCS, United States Department of Agriculture. Available online: http://websoilsurvey.nrcs.usda.gov/. Accessed 28 March 2016.

WESTON, 1999. *Appendix C Geology Report, Modifications to the Container Storage Facility Building 11614 Area, Fort Bliss, TX.* TNRCC Part B Permit Renewal. November 1999.

WESTON, 2015a. *Uniform Federal Policy – Quality Assurance Project Plan for Preliminary Assessment at US Biggs Army Air Field – Snake Pit Site, Fort Bliss, Texas*. April 2015.

WESTON, 2015b. *Technical Memorandum – Draft Amended UFP-QAPP, Subsurface Gamma Survey, Preliminary Assessment at US Biggs Army Air Field – Snake Pit Site, Fort Bliss, Texas*. 18 December 2015.